class, all cases which show a difference in the configuration of the boundaries on the two sides of the plate. All the distributions in the experiments with different temperatures, strengths of solution and of current, belong to the first class; also those distributions obtained in the non-homogeneous fields, and with ebonite screens.

On analysing a non-homogeneous field of larger dimensions, parallel distributions were obtained all along a line running between the electrodes, as well as along a central line at right angles to this. But for some distance from the electrodes at the ends, the plates showed non-parallel distributions.

The paper concludes by drawing attention to the simplicity of the method, and the permanent form of the self-recorded results, and indicates the direction in which it is desirable to extend the research.

III. "On the Tidal Friction of a Planet attended by several Satellites, and on the Evolution of the Solar System." By G. H. Darwin, F.R.S. Received December 27, 1880.

(Abstract.)

The first part of the paper contains the investigation of the changes produced by tidal friction in a system consisting of a planet with any number of satellites revolving round it in circular orbits. The planet's equator and the satellites' orbits are all supposed to be in one plane. The planet is formed of homogeneous viscous fluid, but a large part of the results, due to the particular sort of tidal friction which arises in this special case, would be equally true under a more general hypothesis as to the nature of the planet. The mutual perturbations of the satellites are neglected, so that only the rotation of the planet and the distances of the satellites have to be considered.

It is then proved that if E be the whole energy, both kinetic and potential, of the system, and if ξ be a function of the distance of any one of the satellites from the planet (which function, when the mass of the satellite is small compared with that of the planet, is the $\frac{7}{2}$ power of the distance), the equation expressive of the rate of change of ξ is

$$\frac{d\xi}{dt} = -A\,\frac{\partial E}{\partial \xi}$$

where t is the time, A a certain constant, and ∂ expresses partial differentiation.

A similar equation applies to each satellite, and the whole of the equations form a system of simultaneous differential equations, which

have to be solved in order to trace the changes in the system of satellites.

Expressions are also found for the rotation of the planet, and for the energy E, in terms of the resultant moment of momentum of the system and of the ξ's.

It is then shown how these equations may be solved by series, proceeding by powers of the time. As, however, the series are not rapidly convergent, they are not appropriate for tracing extensive changes of configuration.

The case where there are only two satellites is then considered in detail, and it is shown that, if a surface be constructed, the points on which have E and the two ξ's as their three rectangular co-ordinates (E being drawn vertically upwards and the ξ's being horizontal), then the solution of the problem is expressed by the statement that the point, representing on the surface the configuration of the system, travels down the steepest path.

The contour-lines on this "surface of energy" are illustrated by figures, and the graphical solution found therefrom is interpreted and discussed.

The second part of the paper contains a discussion of the part played by tidal friction in the evolution of the solar system.

It is proved that the rate of expansion of the planetary orbits which arises from the friction of the tides raised by the planets in the sun must be exceedingly small compared with that which arises from the friction of the tides raised by the sun in the planets. Thus the investigation in the first part of the paper, where the satellites are treated as particles, is not applicable to the solar system.

Although the problem of finding the changes in a system, formed by a rigid or perfectly fluid sun attended by tidally disturbed planets, is easy of solution, yet it seemed inexpedient to attempt a numerical solution which should be applicable to the solar system.

It appeared, however, likely that a knowledge of certain numerical values would throw light on the question. Accordingly the moments of momentum of the orbital motion of the planets round the sun, of the sun's rotation round his axis, of the orbital motion of the satellites round their planets, and of the rotation of the planets about their axes are evaluated with such degree of accuracy as the data permit.

From a comparison between the orbital momenta of the planets and their rotational momenta, it is concluded that tidal friction can scarcely sensibly have enlarged the planetary orbits since the planets had a separate existence.

By parallel reasoning (although the argument has much less force) it also seemed improbable that the orbits of the satellites of Mars, Jupiter, and Saturn have undergone very large extensions since the satellites had separate existences, and it seemed nearly certain that

they cannot be traced back to an origin almost in contact with the present surfaces of their planets, as was shown in previous papers to be probably the case with the moon and earth.

The numerical values spoken of above exhibit a very striking difference between the condition of the earth and moon and that of these other planets, and it may therefore be admitted that their modes of evolution have also differed considerably.

The part played by tidal friction in the evolution of planetary masses is then discussed.

A numerical comparison is made of the relative efficiency of solar tidal friction in reducing the rotational momentum and the rotation of the several planets. It is found that the efficiency as regards the rotation is nearly the same for Mars and for the earth, notwithstanding the greater distance of the former from the earth. This point is important with reference to the rapid revolution of the inner satellite of Mars, and confirms the explanation of this fact, which has been offered in a previous paper.

The numbers expressive of the relative efficiency of solar tidal friction are of course very much smaller for the more remote planets than for the nearer ones, but they must not be supposed to represent the total amount of rotation destroyed by solar tidal friction, because the exterior planets must be presumed to have existed much longer than the interior ones. Nevertheless the disproportion between the numbers is so great that it must be held that the influence of solar tidal friction on Jupiter and Saturn has been considerably less than on the nearer planets.

The manner in which tidal friction and the contraction of a planetary mass would work together is then considered, and it is found to be probable that tidal friction was a more important cause of change when the masses were less condensed than it is at present; thus the present rate of action of solar tidal friction is not to be taken as a measure of what has existed in all past time.

This discussion leads the author to assign a cause for the observed distribution of satellites in the solar system. For if, as the nebular hypothesis supposes, satellites are formed when instability is produced by the acceleration of rotation accompanying contraction, then the epochs of instability would recur more rarely if tidal friction were operative than without it; and if tidal friction were sufficiently powerful, an epoch of instability would never occur.

The efficiency of solar tidal friction diminishes as we recede from the sun, and therefore planets near the sun should have no satellites, and the number of satellites should increase for the remoter planets. This is the observed condition of the solar system.

This theoretical view is also shown to explain how the earth and moon came to differ from the other planets in such a manner as to

permit tidal friction to be the principal feature in their evolution, whilst its effects are less striking in the other planets.

Amongst other points discussed are the comparative speeds of rotation of the several planets, and the probable effects of the genesis of a satellite on the course of change afterwards followed by the planet.

The paper ends with a review of the solar system, in which it is shown that the tidal hypothesis is a means of co-ordinating many apparently disconnected phenomena, besides giving a history of the earth and moon since the origin of the latter.

These investigations afford no grounds for the rejection of the nebular hypothesis, but while they present evidence in favour of the main outlines of that theory, they introduce modifications of considerable importance. Tidal friction is a cause of change of which Laplace's theory took no account, and although the activity of that cause is to be regarded as mainly belonging to a later period than the events described in the nebular hypothesis, yet its influence has been of great, and in one instance of even paramount importance, in determining the present condition of the planets and of their satellites.

IV. "On the Female Organs and Placentation of the Racoon (*Procyon lotor*)." By M. WATSON, M.D., Professor of Anatomy, Owens College, Manchester. Communicated by Professor HUXLEY, Sec. R.S. Received December 30, 1880.

(Abstract.)

The paper contains an anatomical description of the female organs and placenta of the racoon. The specimen examined contained but a single fœtus, which was lodged in the right horn of the uterus. The uterine mucous membrane of the unimpregnated horn was richly supplied with glands, which presented the usual structure. In the non-placental area of the gravid horn these glands, although present, were evidently undergoing degeneration and were with difficulty recognised, and then only in a fragmentary condition; whilst in the placental area of the uterine mucous membrane these glands had entirely disappeared.

The author's observations upon the placenta of *Procyon lotor* show that in respect of this organ:—(1.) *Procyon agrees* with all other carnivora, in which that organ has hitherto been examined, in the possession of a *zonary* or *annular* placenta.

(2.) That *Procyon agrees* with all of these in the mode of interlocking of the fœtal and maternal portions of the placenta and in the consequent deciduate character of that organ.

(3.) That *Procyon agrees* with the members of the *plantigrade* sec-